

Base 10 Numeration

O V E R V I E W

Base 10 number pieces are used to provide a model for place value.

Prerequisite Activity

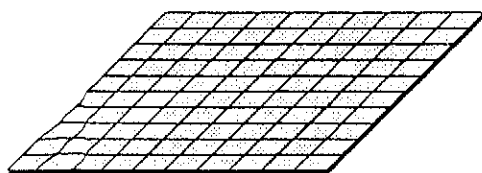
None is required but Unit III /Activity 1, *Grouping and Numeration*, is helpful

Materials

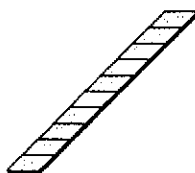
Base 10 number pieces and transparencies of base 10 number pieces for use on the overhead (see Comment 1)

Actions

1. Distribute the base 10 number pieces to each student. Discuss the relationship among the pieces and the value of each piece.



Mat



Strip



Unit

Comments

1. Base 10 number pieces can be made by copying the last page of this activity on tagboard and cutting along the indicated lines. Copies can be made on transparency film and the individual pieces cut out for use on the overhead.

Each student should have at least 13 units, 8 strips and 4 mats. Then, if the students work in small groups, each group will have enough number pieces for each activity. You may wish to have some extra units available for Action 2 (see comment 2).

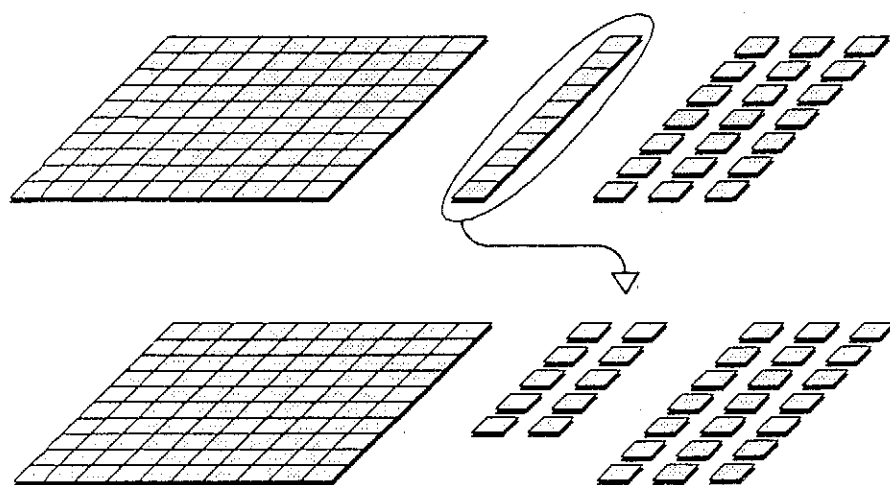
Ten *unit squares*, or simply *units*, arranged in a row form a *strip*. Ten strips side-by-side form a *mat*. Each mat contains 100 units.

In this activity the assumption is made that students know how to count but may not understand the place value nature of our numeration system. For example, they may know how to count one hundred twenty-four objects and even be able to write the symbol 124. They may not, however, view 124 as 1 group of one hundred, 2 groups of ten and 4 units.

Actions

2. Place the following collection of base 10 number pieces on the overhead: 1 mat, 1 strip and 21 units. Point out that altogether this collection contains 23 base 10 number pieces. Make a chart, like the one below, on the chalkboard or overhead and record the information about this collection on the first line of the chart.

Trade the 1 strip for 10 units and record the resulting collection on the second line of the chart.



Ask the students to copy the chart and to add to their chart by making more equal exchanges and recording each result.

mats	strips	unit	Total Number of Pieces
1	1	21	23
1	0	31	32

Have the students help you make a master list of different collections.

Comments

2. For this activity you may want the students to work in groups. Many of the exchanges require a large number of units. Therefore, once students are familiar with the notion of making exchanges, they may want to imagine the exchanges taking place rather than physically carrying them out.

There are 18 different collections that can be listed in the chart. The asterisk marks the collection with the fewest number of base 10 pieces.

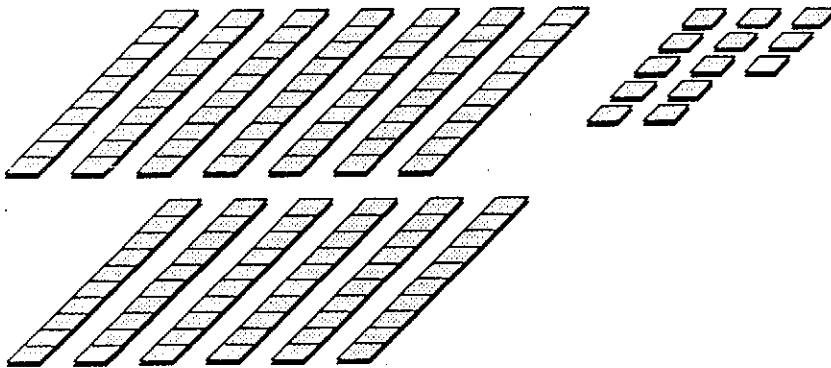
Mats	Strips	Units	Total Number of Pieces
1	1	21	23
1	0	31	32
1	2	11	14
1	3	1	5*
0	13	1	14
0	12	11	23
0	11	21	32
0	10	31	41
0	9	41	50
0	8	51	59
0	7	61	68
0	6	71	77
0	5	81	86
0	4	91	93
0	3	101	104
0	2	111	113
0	1	121	122
0	0	131	131

Actions

3. Discuss the completed chart. Ask the students for their observations.

Point out that all 18 equivalent collections in the chart represent the number 131, and that the collection which uses the fewest number of base 10 pieces is called the *minimal collection* for the number 131.

4. Have each student, or group of students, form a collection of 13 strips and 13 units. Ask them to make the minimal collection for the number represented by this set of number pieces.



Have the students form minimal collections for the numbers represented by the following sets of number pieces.

- 1 mat, 12 strips
- 14 strips, 15 units
- 22 units
- 9 mats, 9 strips, 9 units
- 1 mat, 10 strips, 2 units
- 100 units

Comments

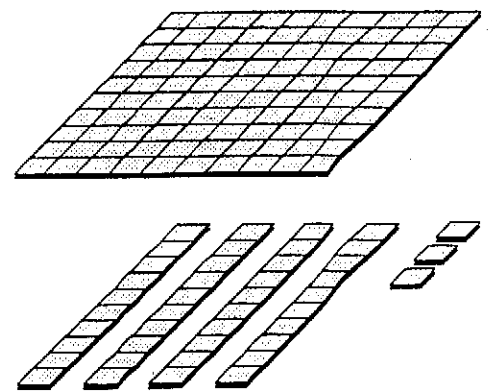
3. Discussion can be prompted by asking questions like: What do the different collections in the chart have in common? Would any one of the collections of pieces cover more area than another?

It is important to see that each collection has the same value. This can be expressed in different ways: if all of the number pieces in each collection were exchanged for units, all collections would contain the same number of units — in this case 131; each collection of pieces covers the same area; or, while making exchanges, the number of base 10 pieces changes but the amount of material remains the same.

Note that the minimal collection for a number will never have an entry larger than 9 in any column of the chart because every group of 10 number pieces, of the same kind, can be traded for the next larger size.

4. The minimal collection for the number represented by 13 strips and 13 units is 1 mat, 4 strips and 3 units.

The minimal collections are:



	mat	strips	units
a)	2	2	0
b)	1	5	5
c)	0	2	2
d)	9	9	9
e)	2	0	2
f)	1	0	0

Actions

5. Put the collection consisting of 13 strips and 13 units on the overhead again. Ask the students to determine the total number of units represented by these pieces if all pieces are exchanged for units. Compare this result with the minimal set obtained in Action 4. Discuss the results.

Repeat this action with other collections of pieces from Action 4.

6. Hold up a large handful of unit squares and tell the students that you have two hundred thirty-seven altogether. Ask them to imagine what the minimal collection for this number of units would be and to represent this minimal collection with their base 10 number pieces. Discuss.

Repeat with some other numbers.

7. (Optional) Display the set of pieces consisting of 9 mats, 13 strips and 11 units and ask the students for the minimal collection for the number represented by this set.

Discuss with students what larger base 10 number pieces might look like. Provide names for these pieces, build or sketch diagrams of them, and determine their values.

Comments

5. With exchanges, the 13 strips and 13 units total of 143 units. The minimal set consists of 1 mat, 4 strips and 3 units. Because a mat is a group of 100 and a strip is a group of ten, the symbol 143 that arose from counting units, can also be viewed as 1 group of 100, 4 groups of 10 and 3 units.

6. This Action is intended to help students think of numbers (and represent them) in terms of place value.

After the students have represented a few numbers with their number pieces, you may want to ask them to draw diagrams of the number pieces which represent selected numbers.

You may wish to extend this action by asking students to imagine what a collection of 237 units would look like if they exchanged as many units as possible for strips. It will be valuable for student to be able to visualize 237 as 2 mats, 3 strips and 7 units or 23 strips and 7 units or 237 units.

7. The minimal collection might appear to be 10 mats, 4 strips and 1 unit. This seems unsatisfactory because it requires more than 9 pieces of the same kind. Creating a larger base 10 number piece solves this problem.

The base 10 number piece model extends to higher powers of 10. An oblong piece consisting of 10 mats in a row is called a *strip-mat* (it represents 1000). A square formed from 10 strip-mats represents 10,000 and is a mat of mats or, simply, *mat-mat*. This process of creating base ten pieces can be continued indefinitely. Ten mat-mats can be grouped to form a *strip-mat-mat* (100,000), ten strip-mat-mats grouped to form a *mat-mat-mat* (1,000,000), etc.